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EDITOR
JURIS ZDANOVSKIS

CO-EDITOR
PATRICK FUNG

Dedication

It is appropriate that this first volume of the yearbook be dedicated to Dr. Edward Mercy. Dr. Mercy came to Lakehead University in 1967 to set up the Department of Geology and so this year marks the first year in which the graduating honours students will have received all of their university training under Dr. Mercy's excellent guidance. Dr. Mercy came to Lakehead University after a distinguished ten year career at the Grant Institute of Geology at the University of Edinburgh. He took his doctorate at the Imperial College of Science and Technology in London in 1955 and has been conducting research in geochemistry ever since. He is a pioneer in the field of development of rapid methods of chemical analysis of rocks and has applied his talents to many geochemical problems. Those who have worked with him know and appreciate his messianic concern with accuracy and woe betide the sloppy or untidy associate.

My three year association with Dr. Mercy at Lakehead University left me with a high regard of his active and aggressive leadership. In the face of overwhelming difficulties he built up a faculty and facility of which any geology department could be proud.

It is therefore with great pleasure that I dedicate this first volume to him and I urge all who follow to strive for the high standard he sets and to continue in this admirable enterprise.

James L. Talbot, Chairman,
Department of Geology,
University of Montana.

Chairman's Message

The production of this Geology Year Book is a major achievement by the geology students of Lakehead University and I congratulate them for showing the initiative, energy, tenacity and the many other qualities needed for the successful completion of their project.

The Department of Geology grew out of a Mining Technology program which had been given since the early days of the Lakehead Technical Institute. The Department, in its present form, is but four years old and our first group of B.Sc. Honours students is preparing for graduation this May.

Our present teaching programs are as diversified as possible and are designed to give students the maximum opportunity to choose directions in which they may develop their talents. Thus we have programs of study of Geology with Chemistry, Geology with Physics and Geology with Economics. We believe that these programs can give students the education and experience needed to enter the whole range of mining and petroleum industries as well as providing the academic basis for going on to graduate schools.

The principal research activities of the Department are concentrated in two areas: a limno-geological reconnaissance survey of the Canadian portion of Lake Superior which is supported by contracts negotiated with the Canada Centre for Inland Waters; and a multidisciplinary investigation of a continuous section of midwest Superior Province crust, from Shebandowan to Pickle Crow, which crosses five juxtaposed Archean belts. This latter research involves the close cooperation of members of the Department with a group of geophysicists and geologists at the University of Toronto.

In this fourth year of the life of the Department I see that we are developing teaching and research programs of good academic quality. We have a faculty and staff who are hard-working persons dedicated to the pursuit of the earth sciences. But when all is said and done, it is the quality of the students which will demonstrate to the outside world the nature of this Department. You young men and women are our ambassadors. Yours are the talents which will make the reputation of our Department known and respected. In the production of this Year Book you are showing that you are a group of people with a lively interest in and concern for your chosen profession. Good luck to you all.

Edward Mercy,
CHAIRMAN,
GEOLOGY DEPARTMENT.

Dr. R. A. Ross, Dean of Science, Lakehead University

It is a pleasure to write this short address to the Geology Club of Lakehead University. I heartily commend the editor, Juris Zdanovskis, co-editor Patrick Fung, and photographers on their enthusiastic enterprise in producing this Year Book. I believe it is the first of its kind to be produced by any of the Students' Clubs in Departments of the Faculty of Science,and the Department of Geology should be justly proud of this agreeable achievement.

The significant role played by geologists in the discovery and development of the resources of Canada is marked by history and yet my belief is that the best is still to come. Reference to the Science Council of Canada Report No. 7 on the Earth Sciences would amply justify the tenor of that statement. The future prospects of exciting and creative work in geology, geophysics, geochemistry and the other earth sciences must appeal to many of our brighter students who are oriented towards the scientific disciplines. Many promising careers are and will be available to graduates in research, development, consulting, management and so on.

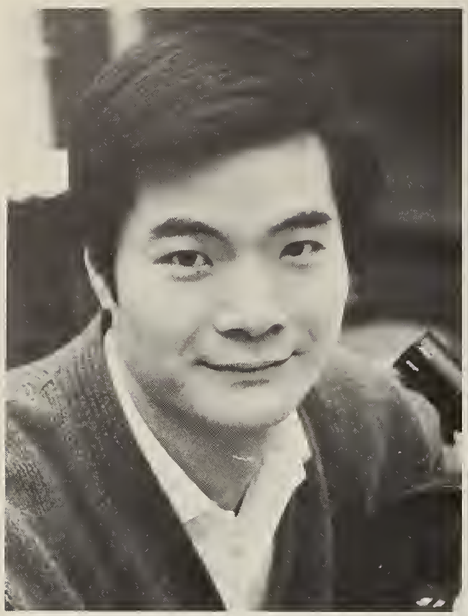
Of course, a successful study of geology means continuous hard work, but when was any worthwhile success or achievement obtained without such effort? Since, in Pantin's terms, geology is an 'unrestricted' science, the graduate geologist must and does have a wider knowledge and appreciation of the other sciences than his colleagues in neighbouring disciplines with the possible exception of the biologist.

I firmly believe that students of geology have chosen their subject wisely. Go to it and your rewards will be many.

To the members of the Geology Club of Lakehead University, I wish every accomplishment in the future and extend my strongest hopes and support for the success of this excellent Year Book.

R. A. Ross

R. A. Ross
Dean of Science



President's Message

It will be appropriate for me to give a brief review on the short history of our Geology Club in our First Geology Year Book.

Our University is young and our club is still younger. But its activities are just as varied and plentiful and our enthusiasm just as high as any. The loosely established Precambrian Club marked the first attempt by the students to organize a club for the Geology Department. But it was in 1968 that the club was first officially established under the name of Lakehead University Geology Club. The executive for the three years of the club's history have been:

1968-69	President:	Lou Covello
	Secretary/Treasurer:	Phil Walford
1969/70	President:	Peter Vanstone
	Secretary/Treasurer:	Joe Kasarda
1970/71	President:	Patrick Fung
	Secretary/Treasurer:	Juris Zdanovskis

When first established three years ago, club activities were limited to gatherings of students, visits to mines and various field trips. In the second year, it began to participate in external activities, including correspondence with other university Departments and geological organizations. It also sent the first group of representatives to the First Central Canada University Geological Conference in Ottawa University. The representatives were: Brian Clerihew, Roy Shegelski, Peter Vanstone. This year, we also sent our representatives to the Second Central Canada University Geological Conference in Queen's University. Our representatives were: Patrick Fung, Rick Middaugh, Roy Shelgeski

Next year, we are going to send one student speaker to the 8th Western Inter University Geological Conference to be held in Manitoba in October, 1971. Also, we have had some very distinguished geologists to be our guest speakers throughout this year. The names of these and their topics are given in another part of this Year Book. It is an honour to have them to come and visit us. I am sure all of us have benefited by their lectures.

The idea of a Geology Year Book was first suggested by Dr. E. Mercy and Dr. J. Mothersill at the beginning of the academic year and was supported by all the faculty members and students. The students from second year were particularly keen and enthusiastic especially the Chief Editor, Juris Zdanovskis. But full credit should be given to all those who helped in producing the Year Book and all those who have contributed to it.

We hope that it will be published every year in the future.

As President I wish the Geology Club every possible success in the future. May I remind you that success depends up the enthusiasm and interest of all the geology students. We have made an excellent beginning - I hope that you will continue this good work.

Patrick Fung,
President,
Geology Club.

Patrick Fung.

Editor's Report

The Geology Department is quite new to this University; it is small and not well known to the rest of Canada; therefore the principal purpose of this first Year Book is to advertise the Department and to make ourselves known.

The first talk of publication occurred at the beginning of the school year, but little was done until a few weeks before Christmas, when a few of us began to consider where the money would come from to pay for the publication. To my surprise, the response was remarkable; the Geology Department was first to indicate mathematical figures that sounded impressive. The Science Society, slow but sure was next in line. The rest of the money had to come from advertising, a source which did not look too promising at first, because of our late start. The companies were agreeable and were sufficiently interested to pull us through with the final cash resources.

Faced with a staff of bushwackers, who had little experience in publishing, we worked slowly; but with all the problems we were still capable of putting out an excellent book.

I should like to thank Dr. Edward Mercy, Chairman, Department of Geology, Lakehead University, for his eager response in helping us to publish the book. Many thanks to the Geology Secretary, Mrs. Jean Helliwell for her help with the business side, and her typing. Without Sam Spivak's help and his artistic talent with the drafting pencil our advertising would have been a mess. I enjoyed working with the staff that I had and hope to have them back next year for the second publication.

If you, the reader, have any criticism of the book, please forward your remarks to me and we shall try our best to improve the book.

Thanks to my staff for their time and patience.

Patrick Fung - Co-editor
Les Tihor - Photographer
Paul Strandberg - Layout
Eric Brown
Elizabeth Hillary
Ron Wrigley
Ron Green
Dave Powers
Ralph Bullough

J. Zdanovskis

Juris Zdanovskis, *Editor.*

with compliments

from

the faculty of

science

lakehead university

R. A. Ross

DEAN R.A. ROSS

" STONEWORTHY ! COLLECT
SPECIMENS, DON'T PRODUCE 'EM "

Olivine diabase dyke in the Coldwell complex.

Algal reef, Gunflint formation, Thunder Bay Group, near Schreiber, Ontario.

These reefs have grown on boulders which form the basal conglomerate of the formation. They contain blue-green algae, and are, at 1.65 billion years, one of the oldest known life forms.

Thinly laminated limey mudstone beds, Sibley Group, near Rossport, Ontario. Note soft sediment folding.

Stromatolites, Sibley Group, Disraeli Lake, near Nipigon, Ontario.

Stromatolites grow in a near shore or intertidal zone. These belong to the genus Conophytum and are 1350 million years old.

Mushroom shaped concretion, Rove formation, Thunder Bay group, near Pass Lake, Ontario.

These concretions have grown diagenetically, and contain possible organic material. They are composed of calcite.

Tightly folded bands of chert-magnetite iron formation in an Algoman Iron Formation, Kaministiquia, Ontario.

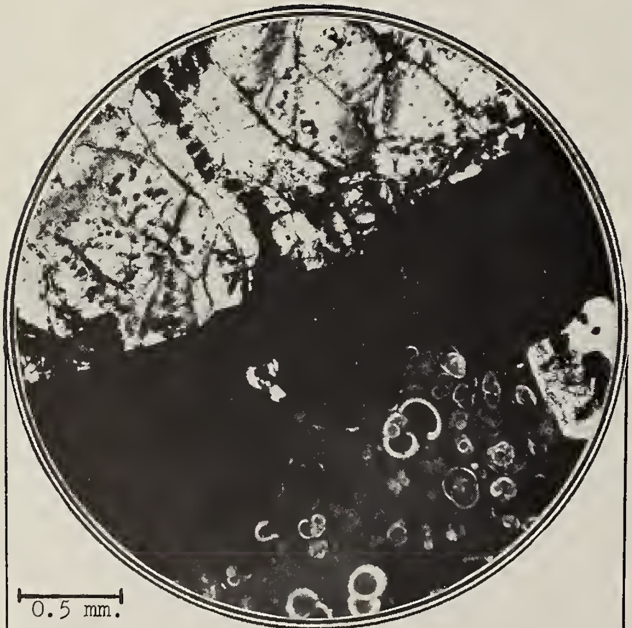
Thin Sections From The Mid-Atlantic Ridge

0.5 mm.

Chromite opaque grains, within a serpentinized ultrabasic rock. In the cavities of the chromite some relics of primary olivine and pyroxene may be found. The fractures in the chromite grains indicate a serpentinization of the surrounding rock with a slight increase in volume.
(45 N, Mid Atlantic Ridge)

Diabase dredged close to the M.A.R.
A rough intersertal structure is formed by coarse microlites of plagioclase and interstitial pyroxene. Probably belonging to a thick flow, or a shallow sill.
(45 N on the Mid Atlantic Ridge, 1200 fms)

0.5 mm.



0.5 mm.

This specimen is a serpentinized dunite. A tiny fracture in the specimen was invaded by a fora minifera ooze, and the walls of the fissure are coated by dendritic Mn and Fe oxides.
(From 45 N, on the Mid Atlantic Ridge, 1300 fms dep)

A quickly chilled basalt, with radiating thin microlites of feldspar, within an opaque hematite stained glassy matrix.
Small angular grains of olivine are visible.
Note the hollow transversal sections of the feldspatic microlite.
(From 45 N, Mid Atlantic Ridge, 1200 fms deep)

0.5 mm.


FACULTY
&
STAFF

Dr. Edward Mercy, B.Sc., Ph.D., D.I.C.

Academic Background

Lecturer in Geology: Imperial College of Science and Technology, London, England.

Lecturer in Geology, later Senior Lecturer in Geology, University of Edinburgh, Scotland.

Professor of Geology and Chairman of the Department, Lakehead University.

Research

Geochemistry of a Granite Series in Donegal, Ireland.

Geochemistry and mineralogy of garnet-peridotites and eclogites from Norway, S. Europe and S. Africa.

Geochemistry and mineralogy of spinel-peridotites from the Lac de Lherz region of the Pyrenees.

Geochemical studies of plutonic and volcanic rocks in Northwestern Ontario.

CURRENT RESEARCH

The mineralogical nature of the mantle of the earth can be deduced in three ways - by considering what known earth materials fit the determined geophysical parameters (such as pressure, temperature, density, value of the gravitational constant, the velocities of seismic waves, and others), by relating the known chemical compositions of basaltic magmas to possible mantle compositions which could produce such lavas by partial or complete melting processes, and by studying the mineralogy and chemistry of rocks, emplaced at high levels in the crust, which might represent unaltered mantle squeezed up into the crust by tectonic processes or brought up as xenoliths in magmas.

There is general agreement that the uppermost part of the mantle and at least some part of the lower crust is made up of the assemblage: olivine + orthopyroxene + clinopyroxene + spinel = spinel lherzolite. This is considered to be representative of granulite facies conditions in contrast to the eclogite facies conditions of the deeper parts of the mantle which is represented by the assemblage: olivine + orthopyroxene + clinopyroxene + garnet = garnet lherzolite. Natural materials which have the appropriate properties are the spinel-lherzolite xenoliths occurring in basaltic lava flows and the garnet-lherzolite xenoliths in the Kimberlite diatremes of South Africa. Another type is represented by the series of small tectonic intrusions of spinel-lherzolite which outcrop in the French Pyrenees.

A period of field work based at the beautiful town of Foix enabled me to make a detailed study of what Lacroix described as the type lherzolite. This occurs at a height of 1300 metres o.d. at the Etang de Lers as a tectonic intrusion into tightly folded and strongly metamorphosed Mesozoic rocks. The lherzolite contains 45-85% by volume of olivine, 10-35% orthopyroxene, 5-20% diopside, and 1-6% spinel. These differences in mineralogical composition are caused by the layered structure of the lherzolite.

The main point of lherzolite work is an understanding of the chemistry of the lherzolites and particularly the distribution of elements such as nickel and chromium between the various mineral phases. Such data can lead to knowledge of the conditions of equilibration amongst the phases and may enable one, in comparison with a very great amount of published work, to establish models for the chemistry of the upper mantle.

Edward Mercy

Edward Mercy

Dr. J. Mothersill, B.Sc. (Physics) Carleton; B.Sc. (Geological Engineering) Queen's; Ph.D. Queen's.

Background

Exploration Geologist for Standard Oil (N.J.)
Senior Geologist for Mobil International Oil Co.

Exploring for petroleum in Turkey, Nigeria, France and Colombia.

LIMNOGEOLOGICAL STUDIES OF THE EASTERN PART OF THE LAKE SUPERIOR BASIN

The bottom topography of the eastern part of the Lake Superior basin consists of a lake-shelf two to four miles wide and a series of north-south aligned, topographical deeps and highs three to four miles wide lakeward, which is in marked contrast to the east-northeast and east-southeast trends of the onshore Precambrian rocks. The temperature of the bottom sediments is related to water-depth. The high pH values of the bottom sediments in Goulais Bay and Batchawana Bay appear to be caused by the alkaline waters of the Goulais and Batchawana rivers respectively. The pH measurements of the bottom sediments elsewhere in the area of study do not appear to be related to either water-depth or to the lake-bottom sedimentary types.

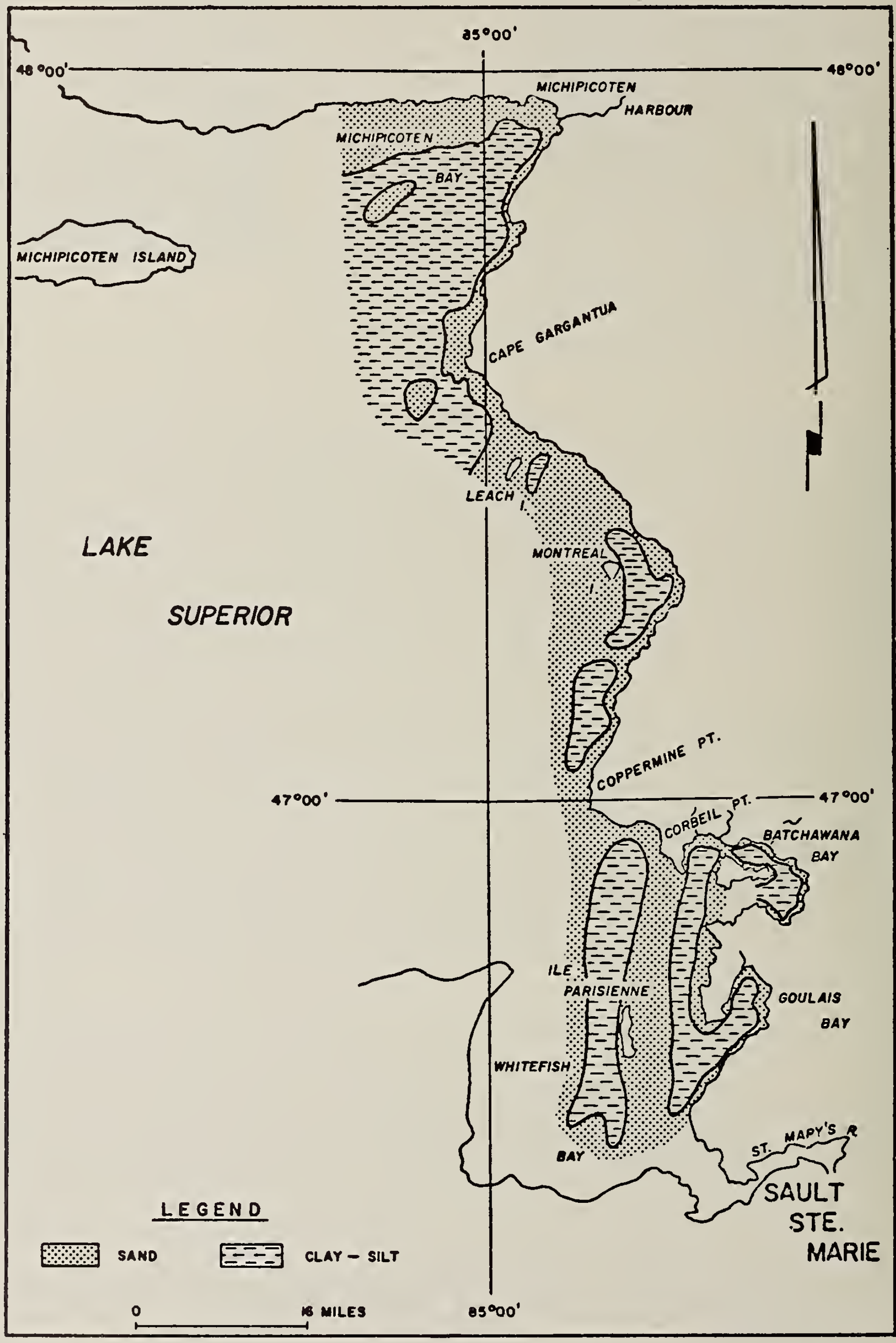
The Recent sand deposition is restricted to the lake-shelf and to the offshore topographical high areas. Based on grain-size analyses the sands of the topographical highs are normally coarser-grained and better sorted than the sands of the adjacent lake-shelf area suggesting stronger current action offshore. In addition the sands of these two environments can be differentiated on the basis of total heavy mineral content as the sands of the topographical highs never contain more than 3.1 per cent heavy minerals whereas the sands of the lake-shelf area may contain from 4.1 to 26.0 per cent heavy minerals. The main area of provenance for the sands would appear to be the rocks along the shoreline and the drainage area of the eastern Lake Superior basin. The reason for the relative decrease in the percentage of heavy minerals present along the topographical highs would appear to be that most heavy minerals are unstable in a fresh water environment and therefore would tend to be chemically decomposed before being transported to the offshore topographical high areas.

The sands south of Coppermine Point are generally coarser-grained, better sorted and less positively skewed than the sands north of Coppermine Point regardless of environment of deposition. This is probably the result of stronger current action along the shallower waters of the topographical highs and lake-shelf area south of Coppermine Point. The occurrence of a thicker sand sequence in progressively shallower water from north to south across the area of study could be related to the post-glacial isostatic tilting of the Lake Superior basin to the southwest as the Michipicoten area has been raised 20 meters relative to the Sault Ste. Marie area since the Nipissing stage (Farrand, 1960).

The Recent sediments in the central parts of Batchawana and Goulais Bay and in the offshore topographical lows consist of coarse silts to coarse clays. These Recent silt-clays form a consistent sequence of the following three units: an upper thin veneer (< 4 cm.) of coarse to very fine-grained dark yellowish brown silt; an intermediate, relatively thin (2-12 cm.), unit consisting of olive gray, fine-grained silt to coarse-grained clay; a lower thick unit of coarse to very fine-grained, dark yellowish brown silt. The thickness of this sequence is greatest in the central parts of the topographical deeps where it is in excess of 180 cm. thick. The mineralogical composition of the three units is very similar and consists of orthoclase, microcline, quartz,

chlorite, illite and an interbedding of chlorite and illite. The difference in colour is probably caused by the higher oxidation state of the dark yellowish brown silts.

Varved sediments, probably of Pleistocene age, underlie the Recent sediments in the area of study. North of Coppermine Point the varved sediments are greenish gray in colour whereas to the south of Coppermine Point the varves have been oxidized to pale brown in colour. The mineralogical composition of the varved sediments consists of orthoclase, microcline, quartz, chlorite, illite, an interbedding of chlorite and illite, dolomite and calcite. It was noted that there is a decrease in the percentage of calcite in the varved sediments northward of St. Mary's River.



JOHN S. MOTHERSILL LIMNOGEOLOGICAL STUDIES OF THE EASTERN PART OF THE LAKE SUPERIOR BASIN.

Dr. Henri Loubat
Geological Engineer, PhD., Geneva
Assistant Professor, Lakehead University

Petrology

I became particularly attracted by petrology in 1961 when I found the opportunity of studying a set of metamorphic rocks from California. These rocks belonged to the glaucophane-schist and eclogite facies of metamorphism. At that time, I was fascinated by two problems exhibited by these classic Californian types: the process of diaphtoresis, and the phenomenon of converging facies.

The "glaucophane-schist" may be due to a particular regional metamorphism acting on greywackes and ophiolites; but frequently it results from a retrograde process of modification from a high degree of metamorphism (amphibolite or eclogite) toward lower degrees of alteration. Both these glaucophane-bearing types are to be found, closely associated, in California, and they exemplify very well the retromorphosis (diaphthoresis) and facies "convergence". It is easy to realize the interest of the study of those facies, if we know that eclogite themselves are not always considered as metamorphic rocks....

Soon after, receiving a grant from the University of Geneva I studied briefly greenstones, sediments and serpentines from Cuba. The degree of alteration of my samples was somewhat discouraging for a sucessful petrographical and geochemical investigation, but this was a first contact with igneous submarine rocks.

During the next four years my main petrographic activity was devoted to surveying the Versoyen region - this area of the Alps is geologically very attractive. We should know that the Alps are subdivized longitudinally by a major tectonic thrust plane, the trace of which is called the "Pennic front thrust". This line runs parallel to the chain, subdivizing it into two equal bands: the "internal Alps" (toward Italy) and the "external Alps" (toward France and Switzerland). The former is very rich in ophiolites, strongly metamorphic and intensely disturbed by the tectonic. The latter is not metamorphic, lacking ophiolites, and gently folded. The Versoyen, which is located exactly on the border between France and Italy, is the last ophiolitic area we could find when leaving the internal Alps going toward France. With this marginal location, this area offers the weakest degree of metamorphism we could have in the Alps for submarine volcanic rocks.

A study based on field, microscopic and chemical investigations leads to the following conclusions:
We have there a well-preserved submarine volcanic complex composed of the piling of various related units; at the bottom, along with slabs of aplitic granites and gneiss (fragments of the Alpine basement?), thin layers of serpentinites. Above, thick lenses of differenciated gabbros; still above, a set of sills, inter-bedded with black schists. At the top, an enormous amount of pillow-lavas. This rather logical sequence so well known by anglo-saxon geologists, was never recognized before anywhere in the Alps, although it is quite probable that it is actually omnipresent, but was always disturbed by complex diastrophism.

Moreover there was an interesting point about the metamorphism of the volcanic system: the intensity of metamorphism was steadily decreasing from the bottom to the top (very weakly metamorphic pillows). I suggested an eventual direct relationship between the depth of the crustal segment and a kind of late-magmatic auto alteration (deuteric alteration).

These are the reasons why I remain personally interested in the results of dredging operations, close to any mid-oceanic ridge. If there were some metamorphic rocks already there, they may well be attributed to some process of alteration of that kind.

As soon as you are occupied by such questions, generally many other interesting problems arise. Studying recently, in collaboration with the Bedford Canadian Oceanic Institute, a set of dredged specimens, I momentarily shift toward another topic of interest: the origin of the dredged serpentinized ultrabic fragments. Among many interesting and mysterious facts, we found evidence of an intense pre-serpentinization cataclasis, probably due to a creeping process at the base of the crust, and presumably related to the oceanic floor spreading. Many metamorphic specimens from 45° N. lat. on the Mid Atlantic Ridge are still waiting for an investigation; we may say already that they uniformly belong to the green schist facies only.

It is fascinating to meet, near Thunder Bay, in the heart of the Canadian Shield, greenstone belts showing perfectly preserved relics of submarine basic lavas, exactly similar to the one formed very recently. It is extremely promising to compare their detailed petrological properties, with those recent equivalent rocks, because we may suppose some kind of difference between now and 3 billion years ago in the superficial environment and in the relations between continents, oceanic crust and mantle. In this comparison, as a petrologist, I foresee the possibility of detecting an evolution of the earth's crust, evolution about which we do not even have a serious hypothetical model yet. The geology school at Lakehead has therefore, a wonderful field of investigations for a long and sucessful future.

Dr. James M. Franklin, B.Sc. (Carleton); M.Sc. (Carleton); Ph.D. (Western).

Background

Geologist for G.S.C.
Assistant Professor, Lakehead University

Research

Metallogeny of the Lake Superior Crustal Traverse, Shebandowan to Pickle Lake

Origin of low temperature silver deposits, Thunder Bay area

Stratigraphy of the Sibley Group, Thunder Bay District

Metallogeny, Its Concepts and Uses

Two concepts of metallogenesis are (1) the genesis of a single metal in a variety of geological environments, and (2) the examination of all mineral deposits within a geologically or geographically defined region.

The "single metal" concept does not facilitate documentation of variations in mode of occurrence with time, and may preclude comparison or integration of genetic ideas related to one metal with with those related to another. This concept does, however, allow for complete examination of the chemistry of concentration of a metal in all geological processes. For example, Gross (1965) in his study of iron deposits, is able to document the processes operative in concentrating iron in igneous (iron-titanium deposits associated with Grenville anorthosites), metamorphic (contact meta somatic deposits of Vancouver Island) and sedimentary (Algoma, Superior and Minette type deposits) bodies. Such a study contributes much to fundamental geochemistry, but may, in certain circumstances, be of less significance in deposit exploration. For example, in searching for copper, the exact nature of the chemical control on deposition of the metal is less important than the stage of development of a eugeocyncline or facies of cratonic cover sediments affiliated with copper deposition. Recognition of the appropriate lithofacies associated with a deposit is a fundamental factor in delineating new areas of exploration.

The second metallogenetic concept involves examination of variations in mineral deposit type within a time-stratigraphic, lithostratigraphic or petrogenetic province. Basically an accurate interpretation of source and time of deposition of mineral deposits is integrated with a regional tectonic history including geosynclinal and post-orogenic evolution. Clearly, a prime difficulty in such a study is selecting useful co-incident geographic and geologic limits. All lithological and structural variations in any time-unit should be included within the geographic bounds of the study. The area must have adequately outlined mineral deposit genesis, paleogeographic and tectonic reconstruction.

Convenient geologic limits might be set by systemic boundaries and orogenic events. For example, the Aphebian era is defined at its initiation by the Kenoran orogeny, and at its end by the Penokean and Hudsonian orogeny. The Helikian era is defined by the latter orogenies at its inception, but the termination of dominant continental volcanism and sedimentation at its end. Together these eras include many conventional tectonic elements. The problem is to select an area in which the complete geosynclinal, mountain building, and continental deposition events are preserved. The Lake Superior and Central Labrador areas meet these requirements. A metallogenic scheme for the former region is outlined in Table 1.

Two uses of such a scheme might be found in mineral deposit exploration and research into early crustal conditions. For example, the exploration geologist may not have been aware of the possibility of "breccia-pipe" porphyrycopper deposits associated with Neohelikian rocks of the Lake Superior area. Examination of available maps indicates the presence of many crypto-volcanic features; more deposits of the Tribag type might be found at appropriate structural loci. Metallogeny might also be useful as an indicator of a specific tectonic stage. For example, if anomalous concentrations of molybdenum are found only in post-orogenic, "high level" salic intrusive rocks, then the presence of this metal in certain Archean granite may suggest that these granites formed much later than the predominant volcanic rocks, in a post-island arc, continental setting. We may thus investigate the possibility of two igneous events in the Archean which may have occurred at widely separated times.

Metallogeny of Proterozoic Rocks in the Lake Superior Area

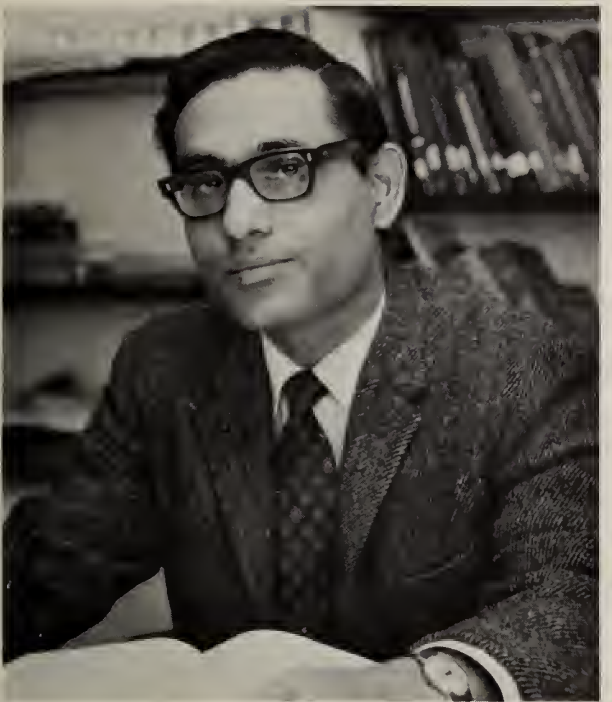
Time m.y.	Tectonic Stage	Sedimentary and Effusive Rock	Intrusive Rock	Structures	Syngenetic Deposits	Multiple Stage Deposits: Source Bed for	Multiple Stage Deposits: External forces, applied, formation of deposits
1000		coarse continental sediments, fine, lamellar interflow sediments (after 'in situ' weathering of volcanics). Flood basalt, minor rhyolite.	minor, alkalic complexes carbonatite. Major layered gabbroic bodies, diabase sheets.	Cratonic faulting and tilting due to deep fracturing.	a) Cu in alkali bodies. b) Cu-Ni in layered mafic bodies. c) Cu in basalt. d) Cu-Mo in breccia pipes (Tribag)[1] possibly as gaseous effusions.	Cu	a) tilting allows updip migration, precipitation of Pb-Zn at structural trap. b) Mafic intrusive sills and dykes cause remobilization of Ag to structural loci formed due to contemporaneous cratonic faulting. c) Cu to interflow sediments.
1350		Continental red bed sedimentation	none				
				uplift, consequent weathering		Pb-Zn-Ba in red beds	
1650	Cratonic		granite granodiorite pegmatites	deformation, simple folding, faulting. Metamorphism in deepest parts of basin, minor anatexis.			
	Protogeosynclinal	blackshale, iron formation, minor basalt, limestone, greywacke.		deeper basin sediment added at same rate as basinal subsidence.	Iron (minor Cu in gabbro)[2]	Ag in shale	
2100	Protobasin	orthoquartzite, cgl, greywacke	minor gabbro	intermontain basins, shallow rapid weathering transport in streams	(Uranium, Elliot Lake)[3]		
2500							

NOTE: Brackets indicate deposits not in region of this study.

1 - Armbrust, 1969

2 - James et al., 1968

3 - Roscoe, 1969



Dr. K. Chakraborty, M.Sc. (Jad.); Ph.D. (I.I.T.)

Assistant Professor, Lakehead University

A Statistical Study of Crystal Contacts Across a Segregated Hornblende Vein in Amphibolite and its Implication

The pattern of spatial distribution of crystals in rocks depends on the energies of crystal contacts and entropy of distribution. The stable equilibrium patterns possess minimum distributional free energy. For a linear unidimensional system consisting of equal numbers of A and B crystals of the same size, the distributional free energy can be expressed as

$$F = \tfrac{1}{2}\, np(U_{AA} + U_{BB} - 2U_{AB}) + nU_{AB} + nkT\,[p \log(\tfrac{1}{2}p) + (1 - p)\log(1 - p)]$$

where U_{AB} = energy of A-B contact, etc., and p = probability of A having another A as neighbour. Thus, for given contact energies, the value of p corresponding to the minimum of F would determine the spatial distribution of crystals in the rocks.

The energies associated with different types of crystal contacts in natural rocks are unknown. However, if p can be determined, it might be possible to decipher the relative energies of the crystal contacts. A possible way to determine p is to carefully evaluate the frequencies of different crystal contacts in a given rock. Frequencies of contacts depend on the preferred crystal associations as well as on the modal percentage of the minerals and crystal sizes. By suitable statistical device (Markov Chain) the frequency of crystal contacts only due to preferred crystal association can be evaluated. Crystal association during crystallization of a rock is governed by other factors apart from contact energies. Hence evaluation of contact energies would be plausible where rearrangement of initial crystal association is apparent.

An attempt has been made to evaluate relative energies of hornblende-hornblende, plagioclase-plagioclase and hornblende-plagioclase contacts from a specimen of amphibolite (hornblende and plagioclase together make up more than 90% by volume). The specimen contains a differentiated zone consisting of a hornblende vein bordered by a feldspathic aureole. It has been concluded elsewhere that the differentiation is later than the crystallization of the amphibolite.

Frequencies of crystal contacts across the differentiated zone are analyzed statistically employing Markov Chain concept. It is observed that hornblende-plagioclase contacts are minimum in the differentiated zone and gradually increase and assume maximum value away from it. The reverse is true for hornblende-hornblende and plagioclase-plagioclase contacts. Thus the distribution patterns of crystals in the amphibolite away from, adjacent to and within the differentiated zone are ordered, random and segregated respectively. This suggests that segregational pattern possesses minimum distributional free energy for this system which is possible if the mean energy of hornblende-hornblende and plagioclase-plagioclase contacts is less than the energy of hornblende-plagioclase contact.

Analysis of Material Balance in Segregated Bodies

Existence of material balance is one of the most convincing evidences in favour of segregational origin of the differentiated features like veins or lenses of mineral "concentrates" bordered by characteristic "aureoles". Analysis of material balance is therefore crucially important and it cannot be overemphasized that the methods employed for such analysis ought to be reliable as well as capable of revealing the true state of balance within the differentiated bodies.

By use of spherical and triaxial ellipsoidal models of segregation the reliability of the methods commonly used for balance analysis are tested. It is demonstrated that none of them can yield correct results. The reason for this is that these methods do not take the true volume ratio of the "concentrate" and "aureole" into account. This volume ratio is an indispensable factor for correct balance analysis. Accordingly, modified procedures to evaluate the state of balance are suggested. Determination of the above mentioned volume ratio in natural specimens is extremely difficult and imposes severe restrictions on the scope of balance analysis.

The state of balance across a hornblende vein surrounded by a feldspathic aureole has been determined by the suggested method as well as by one of the existing methods for a comparative evaluation of their reliabilities. The results obtained by the suggested methods show that material balance exists, thus indicating the segregational origin of the vein. This agrees well with the conclusion derived from mineralogical and chemical evidences. But, as predicted from the model studies, the existing method shows a lack of material balance across the vein.

Mr. R. Bennett, Honours Practical Geology,
Heriot Watt College, Edinburgh, Scotland.

Background:

Chief Laboratory Technician, 1936-1967
The Grant Institute of Geology,
University of Edinburgh.

Researching many kinds of technical approaches to Ph.D. studies.

Presently, Chief Laboratory Technician,
Lakehead University.

Thin Section Making with the Aid of Araldite Epoxy Resin.

Araldite Epoxy (Resin 502, Hardener 956)has the ability to penetrate into the cracks and cleavage planes of minerals and it will bond efficiently the angular particles of semi-consolidated sedimentary rocks, as well as recent sediments and soil samples. The adhesive properties of the Resin are such that it can be used as a mounting media, where such thermo-plastics as "Lakeside 70" cannot be used or are not advisable due to the re-arrangement or twisting of the surface to be mounted.

IGNEOUS ROCKS

The following are some of the ways in which Araldite Resin was used in making thin sections of serpentinites from the Atlantic Ridge of the Azores. These rocks were very fragile and had a coating of manganese over the whole or part of the sample.

The Preparation for the thin section:

Due to the fragmental nature of the sample, it was necessary to bond a part of it even before attempting to cut it. This is done by mixing Araldite Resin (10 parts of resin to 2 parts hardener, by volume) in a thin-walled pliable polythene jar. The specimens to be cut are placed in an oven set at 60 degree Centigrade until the surface is hot to the touch.

Remove from the oven and immerse the portion of the rock to be sectioned in the resin. Return the polythene jar with the specimen to a vacuum oven and impregnate the sample. When the oven chamber starts to evacuate, the resin will start to froth. This frothing is controlled by periodical closing of the vacuum and slowly allowing the air to force the resin into the sample's surface. Repeat this procedure until it becomes apparent that there is sufficient penetration of the resin into the surface of the sample, so that when cold, it can be cut without breaking.

The Cutting:

Remove the sample from its container. A surrounding mass of excess resin is beneficial, as it will preserve the outside edges of the sample.

Clamp the unimpregnated part in the cutting machine and cut off the required part. If the specimen is holding together, then cut a second slab for future work. Wash the cut-off part and examine it under the microscope. Ensure that the surface cracks have been impregnated and if not, dry the slab and return it to the oven to complete drying and warming of the surface for coating with a fresh mix of resin. If the slab is used, it may suffice to place it on the plate to warm for surface coating. Surface coat the slab with resin, impregnating it as before if it was on the hot plate or in the oven. Allow it to set, strip off any unwanted resin with a razor blade while the slab is still hot, to save unnecessary grinding.

When the sample is cold, trim to the size of a slide and grind to a very fine mounting surface, using either coated carborundum paper (400, then 600 grit) or a glass plate with the same abrasive and water. Wash the sample and ensure that the required surface is whole (not pitted) and even.

The Mounting:

This can be done using Lakeside 70 or Araldite resin. Use the former if the surface is hard and not likely to twist and buckle when re-heated, which would cause an uneven mount. The latter should be used if this is apt to happen. If the resin is used as a mounting media, apply a small amount to each surface (the glass slide and the sample surface), press them together to remove all the air and allow it to set at room temperature for 24 hours. This will allow the resin to set sufficiently for grinding.

The Thin Section:

Cut or grind the sample down to the first stage of transparency, using either a diamond bonded wheel or the carborundum method.

It is now that the bonding shows its effect. Due to the differences in structure of the silicates and the manganese crust to transmit ordinary light, it is therefore beneficial to hand grind the now thin section to completion on a glass plate with 600 grit or finer if desired, taking great care to retain the complete surface area.

Having completed this stage to the required thickness, wash the section and dry it with a tissue; then remove the surplus Lakeside or Araldite. If the latter is used, trim the outer edges leaving a small border around the section edge, but do not attempt to remove all the Araldite from the thin section as this will result in the destruction of the sample. Clean the surrounding slide with a solvent such as chloroform or acetone. Clean and cover a covering slip with a reasonable amount of Canada Balsam, warm it on the hot plate until the Balsam flows outward over the cover-slip, and in the meantime warm the surface of the thin section. Do this by holding it over the hotplate without touching it, and then laying the two surfaces together. Remove the covered section from the hotplate, then carefully press down the cover-slip to remove all the air. Clean off the surplus Balsam with acetone and finally with chloroform.

If the thin section is too fragile to use heated Balsam, use Permount and allow to dry at room temperature. This takes longer, but it helps to retain the structure of the section.

SEDIMENTARY ROCKS

The thin sectioning of sedimentary rocks such as sandstones, sandy shales, clay shales, etc. can be difficult when their natural cementing media is a carbonate or some other material (with the exception of silica). It is therefore necessary to impregnate the rock with a material that will act as a bonding substance to retain the grains and structure of the rock in original form.

If the rock matrix is a carbonate, either calcite or dolomite, the action of the cutting blade will tear away the carbonate, leaving many loose grains, and the stages of grinding prior to mounting on the slide will have a similar effect, though not so harsh. If the fine-ground slab is washed down and dried, then examined under a binocular microscope, it will be observed that the cleavage planes of the carbonate have been irritated and are apt to be loose. Therefore, when the slide mounting media is applied to the section slab, and the slide placed in position, a gritty feeling will be observed. The result is a thin section full of holes, due to the fact that all the grain surfaces were not on an even plane.

If the same sandstone were impregnated with Araldite Epoxy Resin, all the grains as well as the cleavage planes of the carbonate would be bonded together to create a solid interior which can be thin-sectioned without any difficulty. The same technique may be applied to sandy shales and the fine laminations of shales.

Method:

Cut the rock with a diamond blade to a thickness of no less than one quarter of an inch, as this will give a sufficient depth with which to work. Dry the slab and place it on a Teflon plate (Use Teflon because of its self-lubricating properties as well as its high melting point) and put the unit in a vacuum oven and bring it to 60 degrees Centigrade.

Mix a small batch of Araldite Resin (such as 20 ml. of resin to 4 ml. of hardener), stir it well and leave it standing until the mass of air bubbles is out. Remove the Teflon plate and the slab from the oven and quickly apply a surface coat of the resin to the slab, and then return it to the oven and re-evacuate the air. When the resin has stopped frothing, close the vacuum valve and slowly open the air vent. The inrush of air will force the resin into the slab. Leave the unit in the oven to cure for two hours and then allow it to cool to room temperature. Remove the slab from the Teflon plate and cut it to the size required for thin section. The grinding for mounting is the same as for a hard rock section.

The mounting media should be Lakeside 70 and the sectioning is the same as before with the exception that the sandstone can be machined thinner, saving hand grinding. The covering is the same as before.

THE IMPREGNATION OF RECENT SEDIMENTS

The following report is on the technical procedure of making a thin section followed by a micro-polished surface of a recent fine grained sediment.

The sediments which are wet when collected in core form are cut along their length to expose the variation in deposition. The selected parts are removed and dried out slowly to prevent excessive shrinkage and to minimize the number of cracks.

Stage I:

The first stage is to grind a flat surface of the selected sample. This is done on dry abrasive paper of 400 grit, and then on 600 grit until the surface is flat, blowing off any excess with a compressed air jet.

Stage II:

The impregnation media is Araldite Epoxy (Resin 502 Hardener 956) (a mixture of 10 parts resin to two parts hardener). Teflon should be used for the mould, as it is a self-lubricating plastic which does not require any releasing agents. It is convenient to have circular rings of varying depths and diameters - these rings are placed on a Teflon plate (one quarter of an inch thick) to prevent bending. The ring is held in place on the plate with a thin layer of silicon grease, which prevents leakage from the mould. Place the sample in the mould, prepare the resin and let is stand to allow any excess air to come to the surface. Wet the surface of the specimen with Methyl Ethyl Ketone, (a resin thinner which invades finer layers, allowing the resin to better impregnate the sample).

Pour the resin into the mould so that it just covers the sample, and then put the unit in the vacuum oven and start to evacuate the chamber. At 15 pounds pressure, the resin will start to froth. Do not allow it to overflow the mould, and to prevent this close the vacuum control valve and slowly open the vent. The inrush of air will start the impregnation of the sample, a repetition of this process should be done until there is no bubbling under the vacuum. Close the vacuum control, switch off the pump and open the vent slowly. When the vacuum is released, set the oven heater at 60 degrees Centigrade and allow it to cure for two or more hours.

Remove the unit from the oven and allow it to cool. Separate the ring from the Teflon plate and press out the sample. The method of preparation for thin section is similar to that of a sedimentary rock, with several exceptions. The surface to be mounted on the slide must be on an even plane with the surrounding resin so that there is no relief between the two. The only way to obtain a flat even surface, if the sediment does not fine grind flat, is by repeated surface impregnation, and careful fine grinding.

Use a fresh mix of resin as a mounting cement. Apply a little to the slide and to the fine surface of the sample and press them together. Leave it to set for at least 24 hours. The now thin section is ground to its proper thickness, after machining as before, on a wet glass plate using 1000 Carborundum, clean and cover with thinned Balsam or Permount.

The Polished Surface

The preparation is the same as for the thin section, with the exception that the sample is moulded in a bakelite ring especially made for the Dürner Polishing Machine.

The most important part of this technique is to obtain a hardened flat surface prior to mechanical polishing. To obtain this surface, it is necessary to carefully dry grind the specimen on fine abrasive paper, with frequent examination under the binocular microscope, to

ensure that a complete mineral surface is present - not one with a microlayer of resin over it. When this is done, and the edges of the mould have been bevelled, it is now ready for the polishing laps.

Lap I:

The first polishing is done with 6 micron diamond powder. After switching on the lapping machine, clean the lap with acetone and a tissue. An even smear of mineral oil, "liquid paraffin" is applied to the lap, and a small "finger tip" of a 6 micron-diamond is run over the lap.

Stop the lap and fit tne specimens to it. The time for the first stage varies as to the texture of the specimen, so it is decided by trial and error. Otherwise, if the lap is running well, one hour should suffice before the first microscopic examination.

As the particles of the metallic oxides and sulphides are very small it is advisable to use medium to high magnification to get a fair reading on the surfaces. If the pits are still present, clean the lap, recharge and rotate for a further hour.

Lap II:

Repeat the same process for the second grade of diamond (1-3 micron) to get more definite results. Here the surface should really show a polish, with small polishing scratches on the ore particles.

Lap III:

The final polish is done with 0-2 micron diamond and a small amount of oil, enough only to lubricate the lap and avoid "snatching" and ejection off the lap.

When the surface is finished, clean it and store in a dry container to prevent moisture affecting the fine sulphides and thus spoiling the surface.

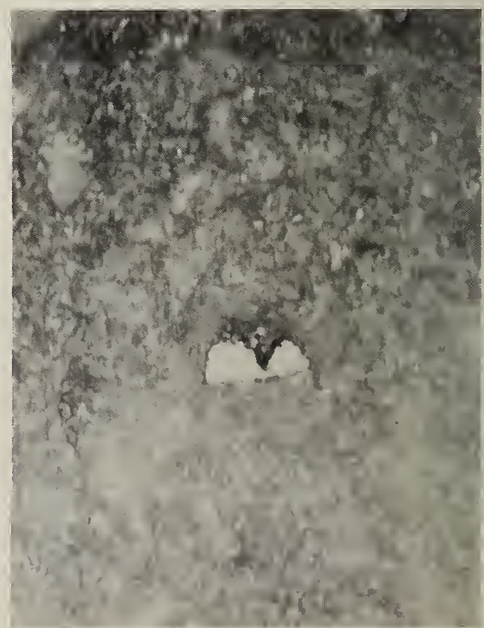
Illustrations:

A. Microphotograph:

Thin section plain light 2.5X
showing - (a) M_n bed.
(b) Fe bed.

B. Microphotograph:

Polished Section plain light 40X
Grainy Pyrite.



TECHNICAL & SECRETARIAL STAFF

Mrs. Ann Sumpter
Laboratory Technician

Mrs. Jean Helliwell
Secretary

Pat Zurkan
Laboratory Assistant

Sam T. Spivak
Drafting Technician

Dick Stephens
Seismic Technician

John Ng
Research Assistant

"AFTER A WHILE IT ALL BEGINS TO LOOK THE SAME."

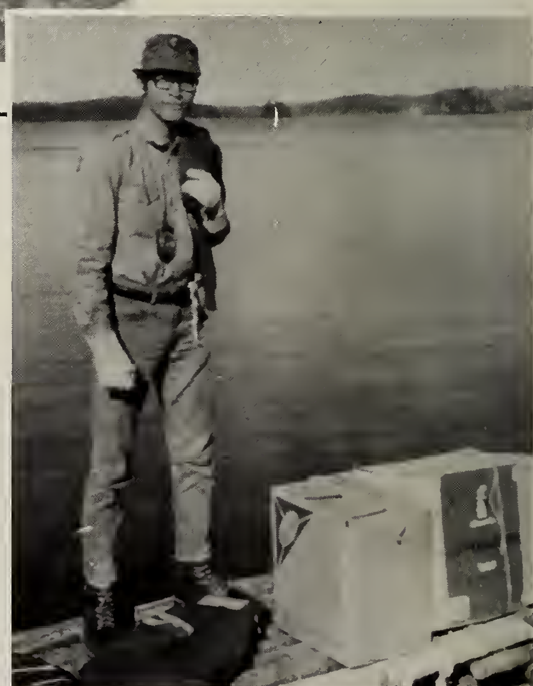
SUMMER FIELD WORK

That's what I call a good cup of coffee!!

All the comforts of home -

And when I strike oil, what do I do then!

Okay, what else do we need besides cigarettes and crackers -- oh-oh, we forgot the toilet paper!



Uh - sir, we forgot the pilot at the airport --

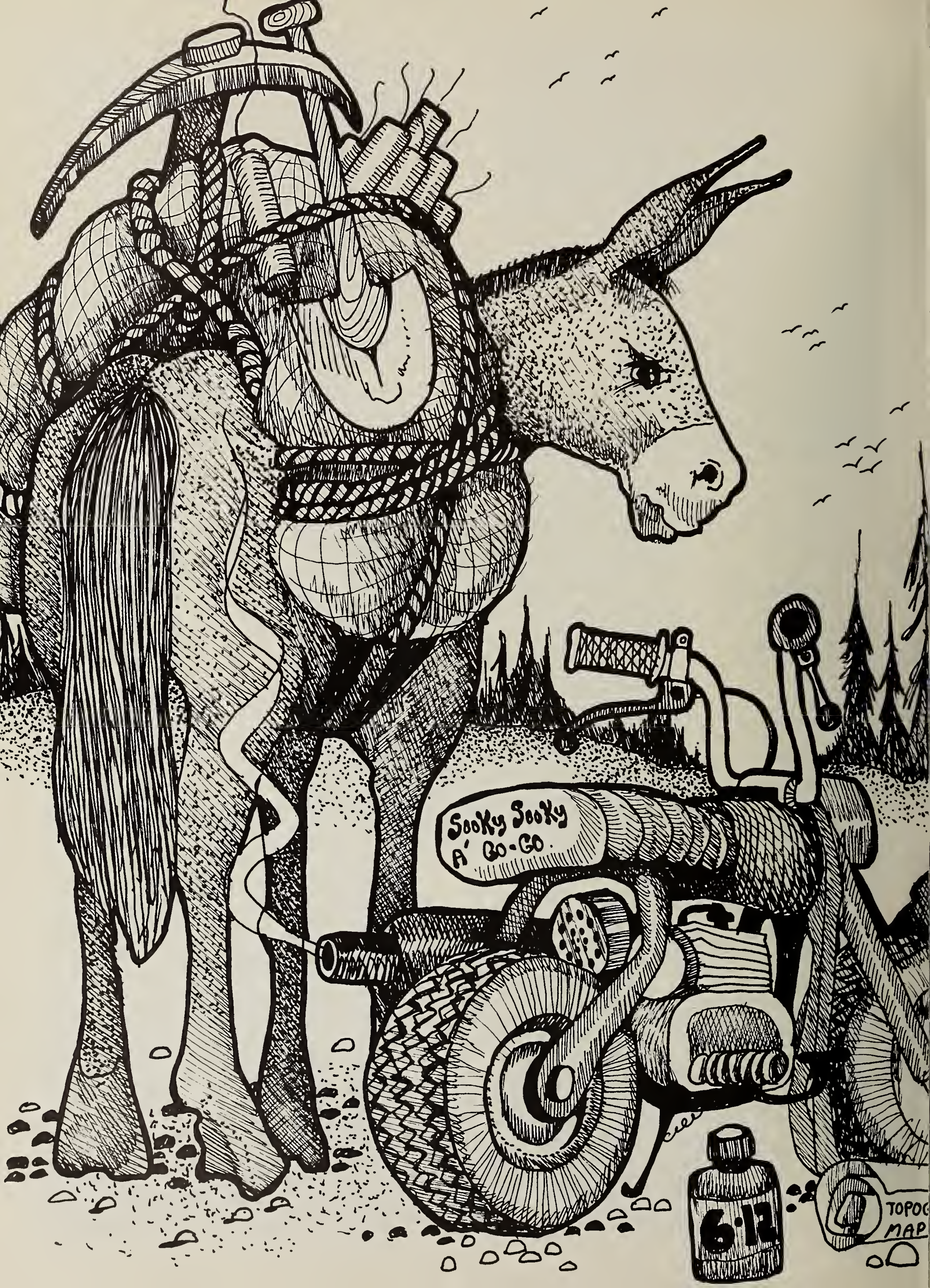
Chinese
Birdcage

What do I do when
the plane starts?

An example of a N.
Ontario cow.

Next time I'll go to a barber.

Now where do I go?


Sooky Sooky
A' GO-GO.
6-12
TOPOG
MAP

"......AND THEN YA CLOBBER THIS HERE ROCK, REAL HARD, WITH THE HAMMER..... REMEMBER THE HAMMER...... THEN YA ...."

Roy Shegelski
Experience: Economic Geology
Limnology - 1969-70
Canada Centre for Inland Waters

GENERAL STRATIGRAPHY AND Fe/Mn BEARING BEDS OF THE SEDIMENTS OF THUNDER BAY, LAKE SUPERIOR

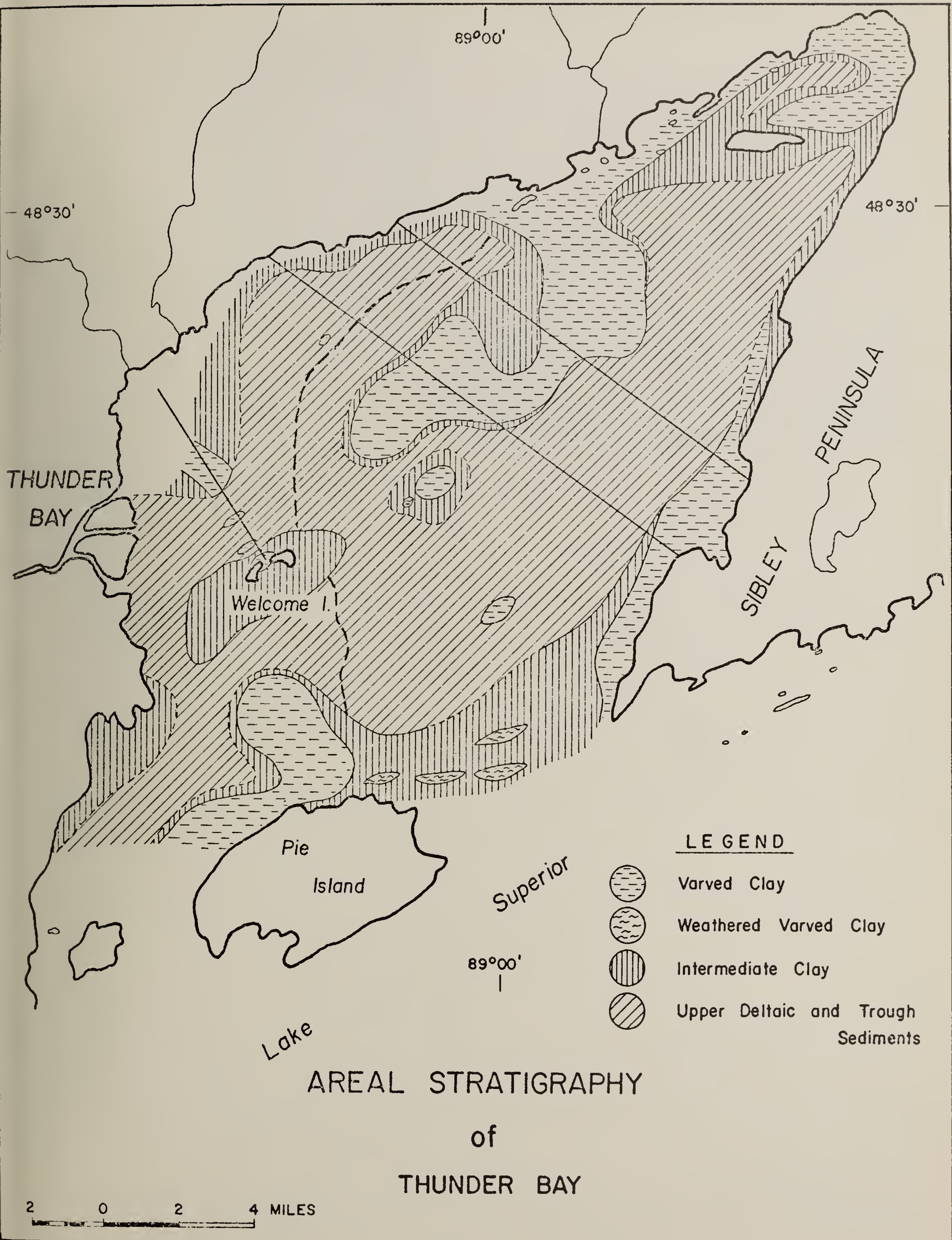
R. J. Shegelski

In the summer of 1970, a reconnaissance survey was done of the bottom sediments of Thunder Bay. This was generally done with a Boston Whaler using a Phleger corer and a Ponar grab sampler and 147 sample points were done in this manner. Three sonar traverses were also made in the Bay.

Samples were brought back to the laboratory for analysis. Cores were split and lithologies were recorded. Samples from cores were analysed by x-ray diffractometer, thin and polished sections were made of various parts and certain layers were analysed for iron and manganese.

Results of analyses indicate that the sediments in Thunder Bay can be divided into five categories. (1) Varved Clay. (2) Weathered Varved Clay. (3) Intermediate Clay. (4) Upper Deltaic Sediment. (5) Upper Trough Sediment. Through correlation of the cores and sonar runs, the stratigraphy has been established as such. The Varved Clay is the oldest, the Weathered and Intermediate Clays are the second oldest and the Upper Sediments are the youngest and overlies the previous types. An areal distribution is shown in the accompanying map.

Results of the iron and manganese analyses indicate that the Upper Sediments contain anomalously high concentrations of iron and manganese. It has been proposed that upward migration of connate waters rich in iron and manganese has produced highly concentrated layers of iron and manganese near the top of the Upper Sediments. The proposed mechanisms of concentration are precipitation, burial subsequent resolution and upward migration causing redeposition at an appropriate Eh, (pH) interface.



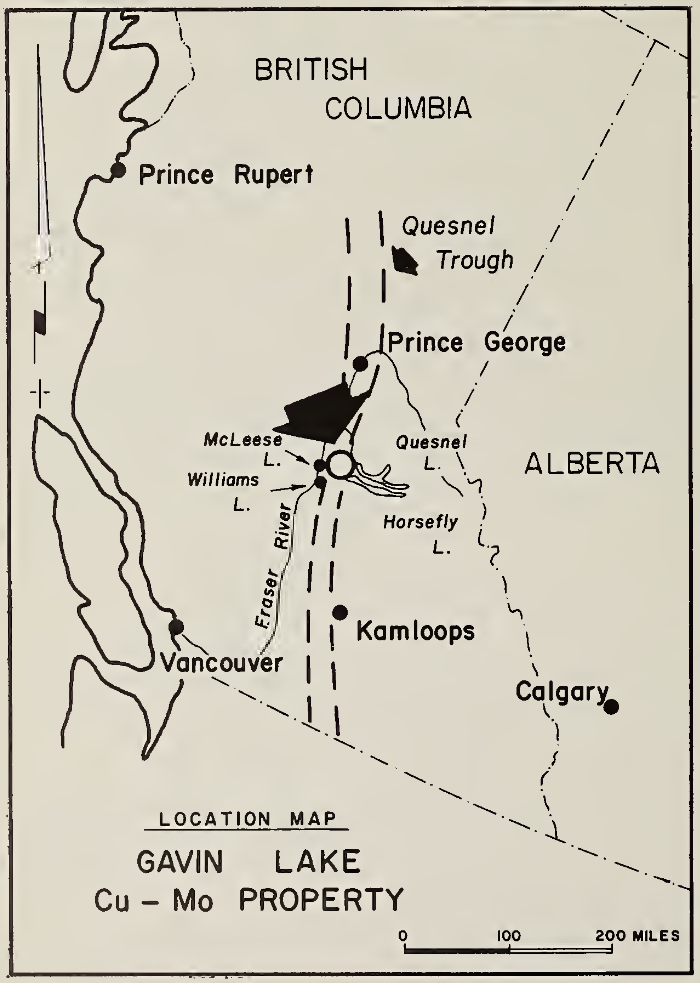
AREAL STRATIGRAPHY
of
THUNDER BAY

Copper and Molybdenum Distribution in the Soils of the Gavin Lake Copper-Molybdenum Property, British Columbia

By Peter J. Vanstone

The Gavin Lake property is located in south central British Columbia, about 25 miles east of McLeese Lake. The property lies on the eastern side of the Quesnel Trough, which is a trough of Mesozoic strata flanked by older Paleozoic and Proterozoic strata.

Geologically, the property consists of two main rock groups: volcanic rocks, which include sediments of volcanic derivation, and porphyritic quartz monzonite. The volcanic sediments cover most of the property, with the volcanic flows occurring as a strip across one end of the property. Intruding into all these rocks is a dyke swarm of quartz monzonite porphyry.



During the last field season a detailed geochemical survey was carried out on the property. The results of these samples were treated statistically to distinguish between the background samples and the anomalous samples. The anomalous copper and molybdenum areas were then outlined. These areas were of three types: high Mo-high Cu, high Mo-low Cu and high Cu-low Mo.

Later in the summer a number of soil profiles were taken across one of each type of anomalous area. Using atomic absorption, these samples were analyzed for total Cu and total Mo. A number of the samples were also selected for partial analysis using E.D.T.A., as an aid in distinguishing between significant and non-significant anomalous areas.

The copper and molybdenum values for the entire property were treated statistically to determine what effect topography had on their distribution. The results of treatment showed lower mean and standard deviation values for the hilltops than for the valley bottoms. The values for the valley slopes were intermediate between the hilltops and the valley bottoms.

Taking into account the pH of the soil, the soil type, the underlying rock type, the topographic location and the copper and molybdenum distribution revealed by the soil profiles, a criterion was formed to distinguish between significant and non-significant anomalous areas.

THE STRUCTURE, STRATIGRAPHY AND PETROLOGY OF THE NORTH END OF THE ABITIBI BLOCK 7, STURGEON LAKE, ONTARIO

Lou Covello

The Sturgeon Lake greenstone belt is typical of the rhyolite-andesite-basalt assemblage of Archean metavolcanic rocks in the Canadian Shield. It consists of thick volcano-sedimentary pile, broadly symfórmal in morphology with a central outcropping of infolded coarse, poorly sorted metasediments flanked to the north and south by the main metavolcanic sequence. The entire greenstone belt is engulfed in a gneissic basement complex and intruded by numerous late Archean granitic plutons.

The north end of Abitibi Block 7 comprises a sequence of felsic and intermediate metavolcanics lying on the south side of the greenstone belt. Detailed mapping of this area has revealed the lithology to have a uniform east-west strike and near vertical dip. Individual rock units are essentially lens-like and relatively undeformed. Metamorphism is of greenschist facies, the common mineral assemblage being quartz, albite, carbonate ± chlorite, ± epidote, ± muscovite, ± chloritoid.

Rhyolitic and rhyo-dacitic rocks tend to be pyroclastic in origin, while more mafic members often occur as pillow lavas, or vesicular and massive flows with minor pyroclastic and ash-flow type interbeds.

PAST EXPERIENCE:

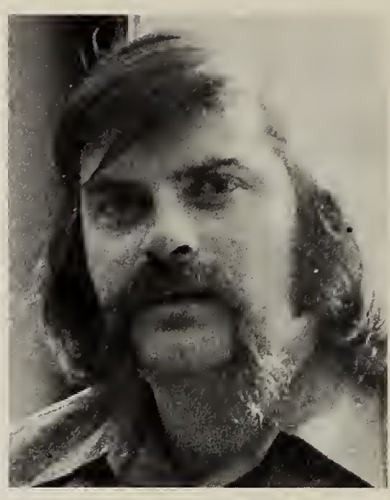
2 summers with Ontario Department of Mines in Timmins and Sault Ste. Marie, Ontario.

2 summers with Anaconda out of the Lakehead.

1 winter with Planet Mining of Sydney, Australia in North Queensland and Victoria.

1 summer with Noranda Exploration in Northwestern Quebec.

1 year with Mattagami Lake Mines, Sturgeon Lake, Ontario.



GENERAL STRATIGRAPHY AND TRACE ELEMENT DISTRIBUTION
OF THE SEDIMENTS OF BLACK BAY, LAKE SUPERIOR

R. D. Middaugh

During the late summer of 1970 a reconnaisance survey of the bottom sediments of Black Bay was carried out. The sampling was done from a Boston Whaler using a Phleger gravity corer and a Ponar grab sampler. Unfortunately, due to weather conditions only 32 stations were completed.

Samples, on being brought to the laboratory underwent various analysis. Grain size analysis were done using sieve and pipette methods. The Ph and Eh were recorded at the top and at various depths along the length of the core. The cores were split and logged and samples were taken at various intervals of x-ray diffractometer analysis and for trace element analysis using the Atomic Absorption unit. The trace elements analysed for were Cu, Fe, Mn, Cr, and Ni.

Results of the x-ray diffractometer analysis indicate that there are three units present. 1) Glacially derived clay, 2) post glacial intermediate clay, 3) upper recent sediments. These units are conformable in the deeper parts of the bay but exhibit erosional contacts near the more shallow margins.

The geochemical data indicate that the trace element concentrations are independent of grain size. The data would also seem to indicate that the trace element concentrations are fairly uniform and show no anomalous values either vertically or horizontally relative to the lithology of the sediments of Black Bay.

EXPERIENCE:

Summer 1968 - General mapping and core logging in the Papaskwasati Basin and the Otish Mountains in North Central Quebec.

Spring 1969, 70, 71 - Limnological studies of Lake Superior under J. S. Mothersill and Canada Centre for Inland Waters.

Experience: Ontario Department of Mines - 1968
Ontario Department of Mines - 1969
Projex Ltd. - 1970

AMPHIBOLES AND PYROXENES FROM THE SYENTITIC ROCKS OF COLDWELL ALKALINE COMPLEX, THUNDER BAY, ONTARIO

M. C. Lee

Amphiboles and pyroxenes are separated from the rock specimens which are syenites and nepheline syenites from the Coldwell Alakaline Complex.

The amphiboles and pyroxenes are determined by both optical and x-ray powder methods.

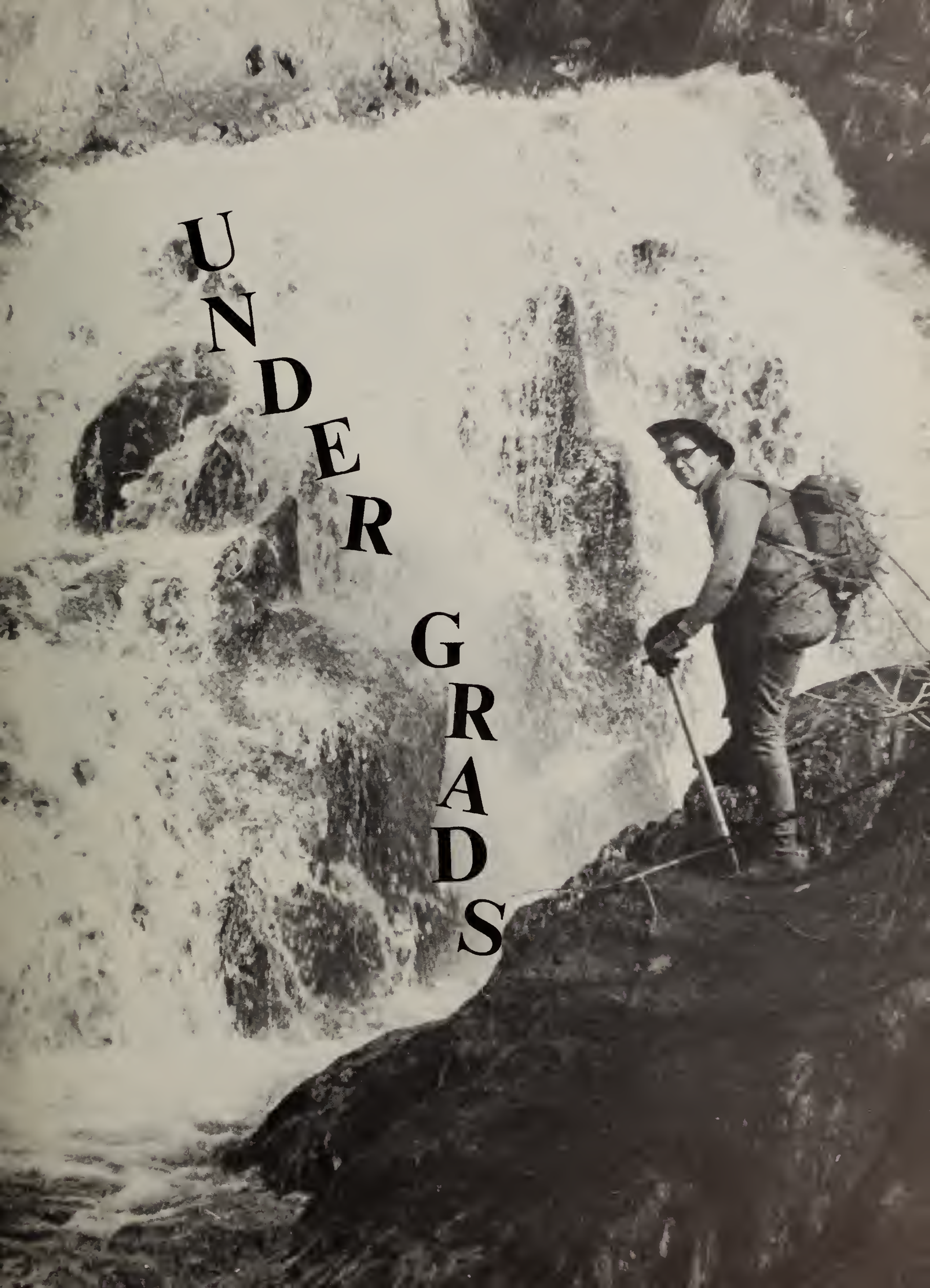
The 2V angles, extinction angles and refractive indexes (α, β, γ,) are determined for these specimens. The pyroxenes are found to be soda augite, aegirine-augite and augite. Zoning is observed; there is an enrichment in aegirine content towards the rim of the crystals.

The amphiboles determined by the optical studies are proved to be ferrohastingsite, hastingsite, and also some riebeckite. Zoning is also observed; the iron content increases from the center towards the rim of the crystals.

Optical determination is a much better method than that of x-ray for these minerals. X-ray determination is a failure for the pyroxenes and amphiboles. It is due to the fact that the cell parameters of diposide is very similar to those of aegirine and augite. The same factor affects the x-ray determination of amphiboles; the cell parameters of riebeckite is very similar to those of ferrohastingste and arfverdsonite.

The course of crystallization of these pyroxenes seems to be:- soda augite → aegirine-augite → Aegirine. According to Aoki (1954) as well as Yaki (1966), crystallization in the mentioned trend takes place under low temperature and high oxygen partial pressure conditions. When the crystallization trend is moving towards the aegirine-rich members, the temperature is decreasing gradually and the oxygen partial pressure is increasing simultaneously.

From the analytical results; the sequence; - Ferrohastingsite - Arfvedsonite is suspected to be continuous. Formerly, both riebeckite and arfredsonite are suspected to be the final end product. The presence of riebeckite in some rock specimens of Coldwell Complex has shown that riebeckite is the final end member of the series.


UNDER GRADS

3rd YEAR

Patrick Fung

Interests:
Geochemistry

Experience:
Ontario Department
of Mines - Mapping
Research Assistant
at Lakehead
University

Allan Chan

Interests:
Ore deposits

Experience:
Mapping, geophysics,
geochemistry, claim
staking with
Falconbridge Nickel
Mines, Ltd.

Ed Grootenboer

Interests:
Exploration Geology

Experience:
Seven years employed
in all phases of
exploration geology

Brent Paske

Interests:
Structural Geology

Experience:
2 years mapping with
the Ontario Department
of Mines

Joe Kasarda

Interests:
Mapping and Structural
Geology

Experience:
Ontario Department of
Mines 1969
Conwest Exploration
Co. Ltd. 1970

John F. Scott

Interests:
Mineralogy, Petrology

Experience:
Varied, in North
Western Ontario

2nd YEAR

George Einarson

Interests:
Geochemistry

Experience:
Engineering surveys with the Department of Highways

Ron Green

Interests:
Economic Geology

Experience:
Recent transfer from Chemical Engineering - no field work in Geology as yet

Bob Kyryluk

Interests:
Geophysics, music

Experience:
Prospecting in British Columbia

Stuart McEwen

Interests:
Exploration Geology

Experience:
Griffith Mine, Red Lake - summers of 1969-70

Rich Niels

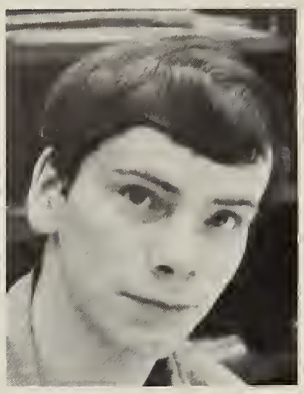
Interests:
Geological Mapping, Geology field trips, Photography, Skiing, Fencing, Judo

Experience:
Geological Mapping with the Ontario Department of Mines - summers of 1965-70

Allan Speed

Interests:
Passing Geology

Experience:
1967 - Great Lakes Nickel
1968 - Great Lakes Nickel



Brian Nieminen

Interests:
Structural Geology

Experience:
2 summers at Ontario Water
Resources Commission Chem labs
- water testing

Les Tihor

Interests:
Prospecting, Photography

Experience:
1967 - Noranda Explorations
1968 - Falconbridge Nickel Mines
1969 - Noranda Explorations
1970 - Falconbridge Nickel Mines

Paul Strandberg

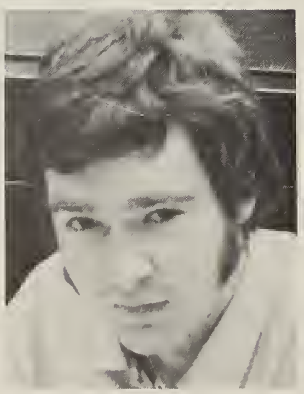
Interests:
Exploration Geophysics
and Petrology

Experience:
Ontario Department of
Mines Geophysical
Party - summer 1970

Juris Zdanovskis

Interests:
Prospecting, Hunting and fishing,
Photography

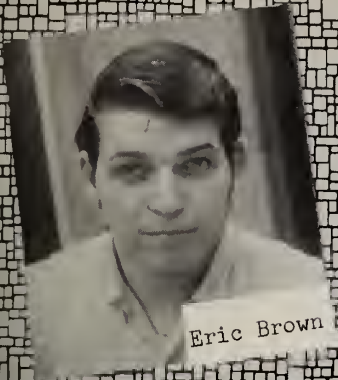
Experience:
Noranda Mines - summers of 1966-69
Falconbridge - 1970



Gord Trimble

Interests:
Economic and Mineralogical Geology

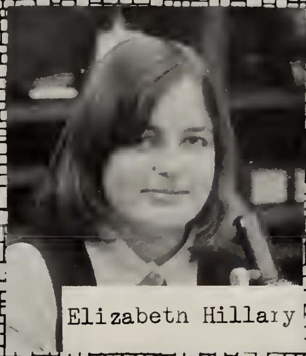
Experience:
Worked with Falconbridge on recent New Brunswick
ore find - summer of 1970


Eric Brown


Mario Silva.

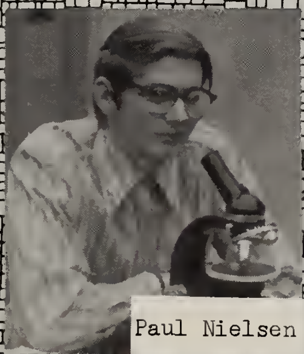

David Powers

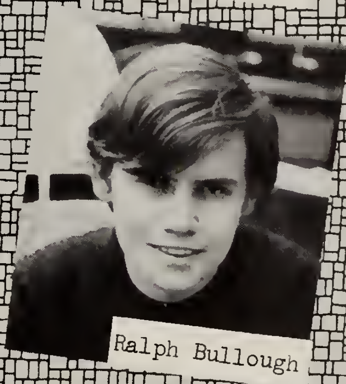

Bryan Heppler


Elizabeth Hillary


Roy Rosentreter

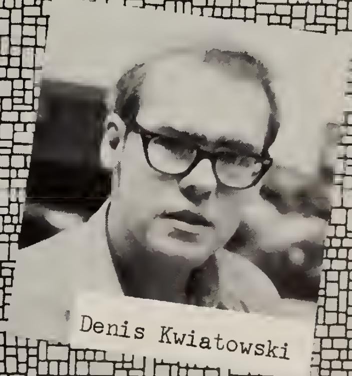

Dan Daciw


Paul Nielsen

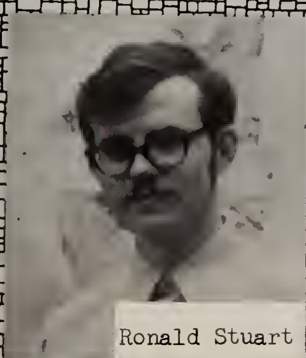

Ralph Bullough


Peter Friske

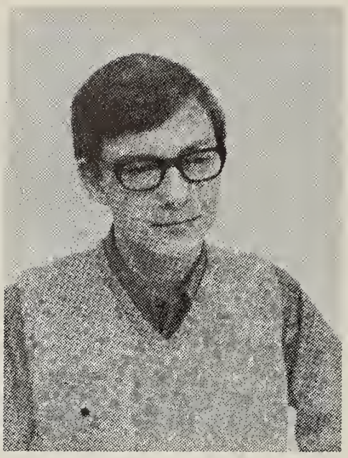

Ronald Wrigley


Denis Kwiatowski


Chris Larson


Ronald Stuart

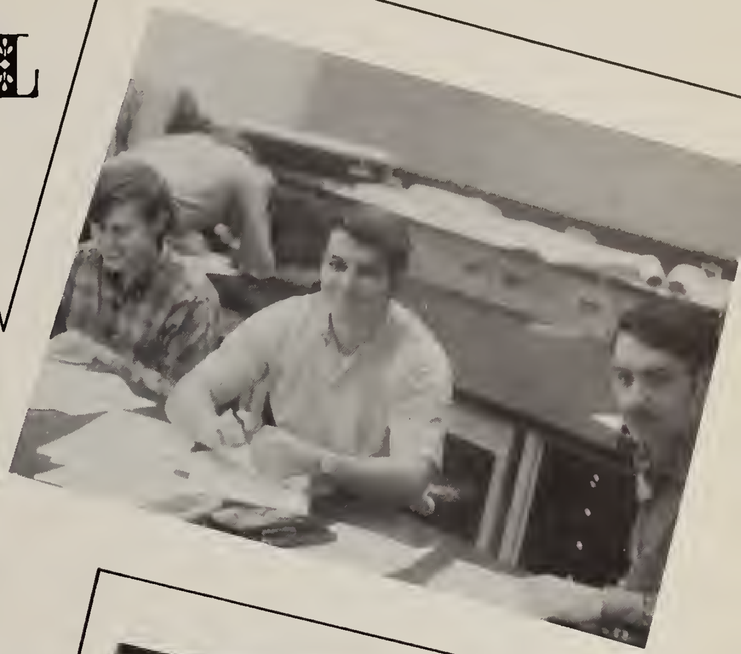

David Busch



Awards

Mr. George Einarson, second year Geology Major student, has been awarded a J.P. Bickell Foundation Scholarship valued at 1,500 dollars. This award is made on the basis of five A grades in first year studies and is paid over a three year period, providing a sufficient average is maintained. Mr. Einarson was born in Winnipeg but moved to Thunder Bay in 1955 with his family. He attended Westgate Collegiate and Churchill High Schools, and continued directly on to studies in the Geology program at Lakehead University. He becomes the second student majoring in Geology to receive a Bickell Scholarship. Mr. Patrick Fung, now a third year student was awarded his scholarship in the Fall of 1969.

L



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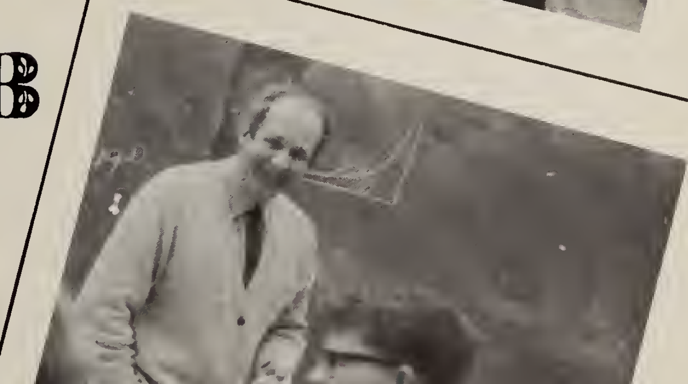

S

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The modern-day explorer. Years ago, they would have given him three ships, a Godspeed, and called him hero. Today, it's a helicopter. And today, they call him geologist. Modern-day explorer. And, possibly hero. For one day he may set down his modern-day ship upon a wilderness. And, on that day, he just may find an ore body. And a community will be born. A community with opportunity for developers, processors, designers and more. Opportunity that will be fulfilled without sacrificing the natural beauty and environment of that first discovery. Inco can make this community happen. But Inco cannot do it without you.

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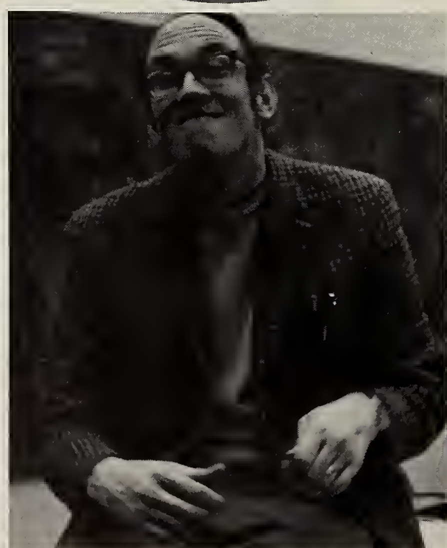
~~SLEEPING~~
GIANT
FIELD SAMPLES
C-72

Geolgists Defined

He who with pocket-hammer smites
    the edge
Of luckless rock or prominent stone,
    disguised
In weather-stains or crusted o'er
    by Nature
With her first growths, detaching by
    the stroke
A chip or splinter - to resolve his
    doubts;
And, with that ready answer
    satisfied,
The substance classes by some
    barbarous name,
And hurries on; or from the fragments
    picks
His specimen, if but haply interveined
With sparkling mineral, or should
    crystal cube
Lurke in its cells-
    and thinks himself enriched,
Wealthier, and doubtless wiser, than
    before!

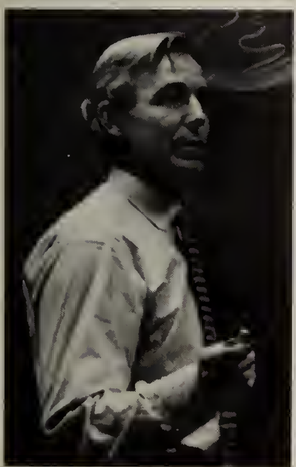
-WILLIAM WORDSWORTH.



Visiting Lecturers

Dr E. H. Chown
Loyola University, Montreal
Topic: "The Geology of the Otish Mountains, Central Quebec".

Dr J. Tuzo Wilson
Principal of Erindale College and Professor of Geophysics at the University of Toronto
Topic: "Continental Drift and Plate Tectonics"



Dr E. Irving
Earth Physics Branch
Department of Energy, Mines and Resources
Topic: " The Origin of Marine Magnetic Anomalies".

Dr M. M. Kehlenbeck
Queen's University
As of July 1st, 1971, Assistant Professor of Geology, Lakehead University
Topic: "Deformation and Recrystallization Textures in the Pipmuacan Anorthosite, Quebec".

Patrick W. G. Brock
Visiting Professor, Queen's College of City University of New York
Topic: "Precambrian Shield in East Africa: structural age relationships of intrusive and metasomatic alkaline rocks. Geomorphological studies of East African Rift Valleys".

Dr. R. H. Ridler, Ph.D., University of Wisconsin

Two years post-doctoral study, University of Western Ontario.

Presently, Research Scientist, Geological Survey of Canada.

Five summers with the Ontario Department of Mines.

Research

Archaean volcanic stratigraphy and mettallogeny, in particular exhalite and gold.

Gold Metallogeny and the Geological Cycle in the Archaean Abstract

Archaean geology is characterized by polycyclic assemblages of related plutonic, volcanic and sedimentary rocks representing the de-sialification of the proto-mantle. The ideal cycle comprises, from oldest to youngest, a mafic volcanic plate accompanied by mafic intrusives; a felsic volcanic pile accompanied by felsic intrusives; and annuli of volcanigenic sediments. Folding may precede or follow a cycle or, rarely, intervene between members of a cycle. Regional deformation and metamorphism conclude the Archaean; stabilization, uplift and brittle failure follow.

Intrusive, volcanic and sedimentary phases of a cycle have accompanying syngenetic gold mineralization. Both clastic and chemical sedimentary deposits are known. Volcanigenic chemical sediments (exhalites) are particularly favourable.

Exhalites have traditionally been classified into oxide, carbonate, sulfide and silicate facies to which arsenide, sulfate, and halide should be added. A further subdivision into subfacies based on cation population is proposed, e.g. (Fe/Cu/Zn/Ag/Pb/(Au?) ---) sulfide. Sampling of diverse species of exhalite at the south margin of the Abitibi Basin indicates a close affinity of gold and sulfur.

Ductile and brittle deformation and metamorphism have recrystallized and remobilized the gold anomalies to varying degrees. Complex gold-quartz vein histories are a common result but migration of gold is restricted to a few tens of feet or less.

Report on First Year Field Trips

by

Eric Brown and Dave Powers

Under the supervision of Dr. Mercy, Dr. Mothersill and Dr. Franklin, we first year Geology students proceeded on two field excursions. The first involved a three-fold purpose: one, to acquaint us with the unconformable nature of the Sibley Archean contact, and the paraconformable nature of the Sibley-Rove contact; two, to observe bedding, ripple marks, a sedimentary sequence of chert, mudstone, sandstone and conglomerate; three, to view some diabase sheets which cut across the bedding. On the second field trip we proceeded to Pardee Township and Pigeon River to observe cuestas, dykes and concretions in the Rove shale. This trip also took us to the exploratory site of Great Lakes Nickel Company.

Our first stop on the Sibley group field trip was at the site of the Wolf River. Here the professors pointed out to us the sequence of varved clays in the sedimentary bedding through which the Wolf River has cut. The next stop, at a gravel pit near Kama Bay hill, served somewhat the same purpose - to illustrate the bedding and distribution of grain sizes. At Kama Hill a number of geomorphological features were pointed out to us. They included the following: a large anticlinal fold; interbedded mudstone and sandstone; small lenticular or discontinuous diabase sills; a chert horizon, with fine lamination of interbedded carbonate and anthraxolite; massive mudstone; purple shale; and a thick diabase cap rock.

After these observations we moved on to scrutinize a deposit of red sedimentary rocks that had been intruded by a diabase sill. This sill had penetrated down through the sedimentary rocks into the Archean basement. We made our next stop in the region around Red Rock, and saw several outcrops of Sibley rocks, followed by a region of granite outcrops. The next point of interest was a quarry composed of black Rove shale overlying a Gunflint formation. Embedded within the Rove shale were large, irregular carbonate concretions, possibly of organic origin. The final stop of this trip brought us to an exposed basal unit of the Sibley group which is comprised of polymictic conglomerates. Here also was exhibited a well-defined contact zone between the conglomerate and sandstone.

On the second field trip we headed south to the United States border. A range of eroded mountains known as the "Norwesters", which includes Mount MacKay, follows the east side of the highway. The cuestas are composed of black shale (Rove formation) with a diabase cap. As we proceeded southward, the topography changed to one of more rugged relief which is related to the bedrock geological changes.

The Great Lakes Nickel Company exploration project was the first stop on this trip. Our group climbed up to the adit, which was constructed by the company into the sulphide zone, to investigate the rocks in and near the adit. After stripping the adit of most of the available chalcopyrite outcrops, we returned to the bus. On our next stop at the Middle Falls Campground on the Pigeon River, we were mainly concerned with the diabase dyke which cut across the region and gave rise to the falls. The dyke crossed the highway to where it cut into a Rove shale formation; the contact zone between the dyke and the shale was closely observed. Also, the same carbonate mineral concretions evident at the Rove shale quarry mentioned before were evident here.

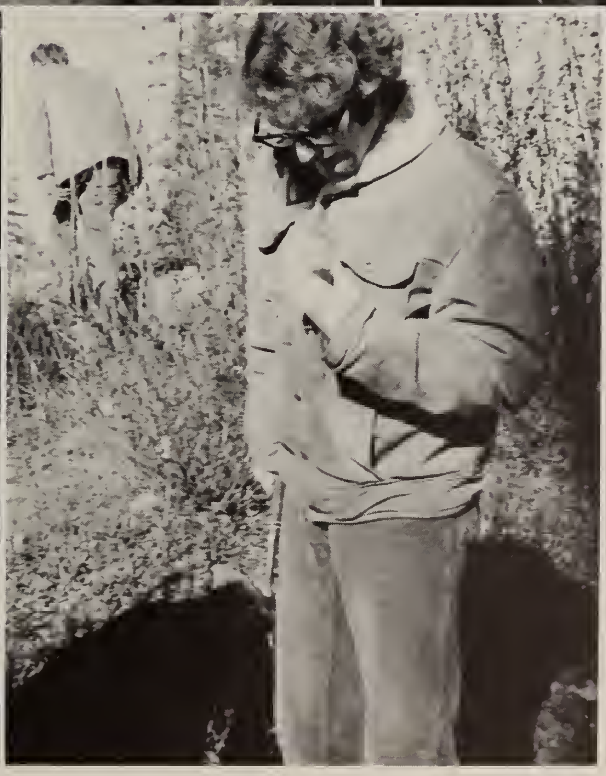
Our last stop was at the end of Memory Lookout Road. At the lookout it was pointed out that we were standing on a dyke which could be visually followed (intermittently) to the south, as it stands up above the surrounding country rock in that area. Two other dykes could also be observed which ran parallel to the dyke on which we were standing.

The significance of these field trips was not fully realized until such time in the academic year when some of the processes involved in the formation of these geomorphological features were comprehended.







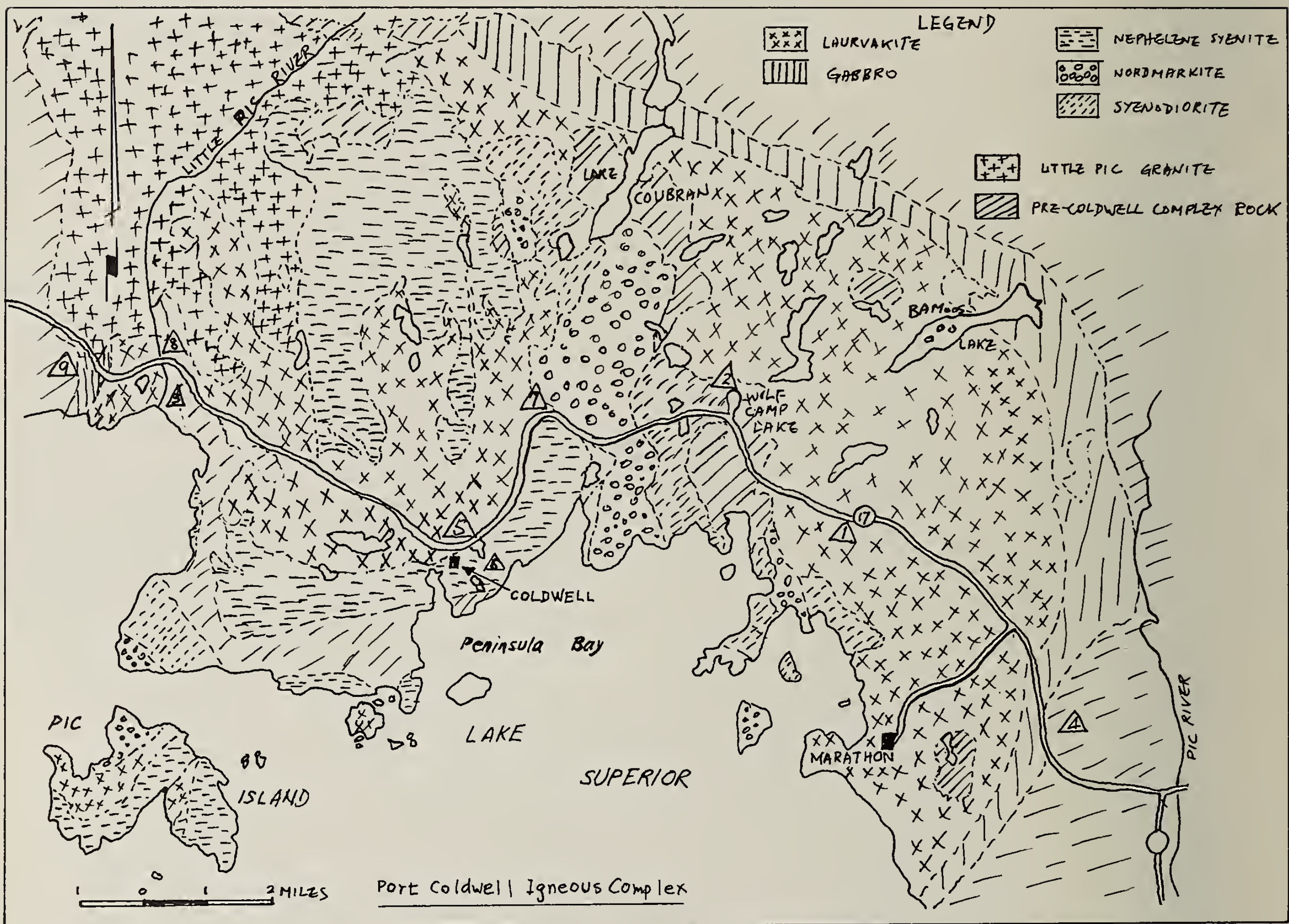


<u>Report on Field Trip to Study Some Features of the Coldwell Alkali Complex</u>

Sept. 8th-11th, 1970
by Pat Fung

Party: Director: Dr. H. Loubat
Members: 3rd year students, Lakehead University
A. Chan, P. Fung, J. Kasarda, B. Paske, J. Scott

Our field trip was intended to study some interesting features of the Coldwell Alkali complex. The main stops we made, together with a general geological map of the area, are given in the map below.



This complex was intruded into the Archean Greenstone belt in Keeweenawan time (+1065 m.y. to 1225 m.y.). At stop 4 the gabbro of the complex comes into gradual contact with the impure arkose of the Greenstone belt, forming a contact metamorphic aureole of gneiss. At some places lenses and veins of quartz, aplite and calcite, with pockets of syenite were found in the gabbro; and in some outcrops, magmatic bandings in the gabbro were seen. These features indicate an intrusion of a mainly gabbroic magma with local varieties and perhaps a later intrusion of syenite. The contact at stop 9 was much simpler. Walking east we passed from highly metamorphosed (granulite facies?) well-bedded claystone, through lenses and veinlets of syenite which increased in content until, through a few tens of metres, it was pure syenite.

In several outcrops we saw xenoliths of different sizes and composition, mainly basalt. For example, at stop 2, just off the highway, was a large xenolith of basalt, and at stops 3 and 4 there were xenoliths of basalt and breccia in the syenite. Most of them showed evidence of slow sinking. F. Puskas suggested that these were from the Coubran Lake volcanic cap and that the intrusion was a lopolith where the present level of exposure is near roof. The consistent fracture and shear zones might also expose some interesting structures. For instance, at stop 4 there was a domelike structure with pre-Coldwell rock sheared and fractured on top of the Coldwell gabbro. Also, at stop 9 near the western margin of the complex, there were two main directions of fracture - one vertical and one horizontal in the south-east direction.

The rocks in the complex show complicated structural and age relationships as well as diversified composition. The oldest was the gabbro, followed by laurvakite, syenite and related rocks. But at stop 4, within a few feet the gabbro changed in composition from common to leucocratic gabbro due to an increase in acidic content. This change might be due to the interaction of syenite with gabbro (hybridisation). The laurvakite also shows variations in composition - at stop 1 it was much altered, with plenty of quartz, calcite and pegmatite veins. The laurvakite is also rich in olivine in molybdenite, and native Mo., but in areas such as stop 8 it is very fresh and approaches the composition of a syenite. Most impressive of all are the variations in the syenite. In stops 2 and 8, the feldspars are very pinkish, probably rich in hematite due to alteration. At stop 2 it was intruded by the rhombopyre dyke near the Bamoos Radio Station, implying an older age relative to the rhombopyre dyke. At these stops, the syenite shows an intersertal texture of the potassium feldspars in a matrix of mainly mafic minerals, with evidence of agpaiitic sequence of crystallization. The syenite is much altered whereas the rhombopyre is rather fresh.

At stop 4 we actually saw some xenoliths of syenite in the gabbro, but at stop 5 the nephelene was very prevalent in the syenite, which is rather fresh with alteration only of nephelene to zeolite. Finally at stop 5, on our way down the railway road near Port Coldwell, we saw the fresh nephelene syenite dying out into the altered, pinkish normal type of syenite - and yet at stop 7 two series of syenite veins cut each other, in diabase. These observations imply that the intrusion is not as simple as F. Puskas has anticipated. It can only be explained by the occurrence of multi-stage crystallization and local variation in the order of crystallization. Generally, the main part of gabbro crystallized out first, then the normal syenite which became altered either before or during the intrusion of the rhombopyre dyke, followed by the intrusion of the syenite by the dyke. A second and significant portion of syenite rich in nephelene crystallized out, breaking up some older syenite and the rhombopyre dyke. Somewhere another, but insignificant, portion of gabbro crystallized out and engulfed some of the older syenite.

The laurvakite generally fits into the pattern after the crystallization of the first portion of gabbro, but another part might have formed later - or the change in composition and amount of alteration can be attributed to local magmatic differentiation and environment alone.

As seen at stops 1 and 5, the pegmatites and others in various rock types were always of late origin. They usually occurred in veinlets of the parent rocks and showed similar mineralogy, but their grain size and composition altered relative to the distance from contact. For example, the pegmatite at stop 6 can be attributed to the late magmatic portion of magma rich in volatiles, crystallized in fractures in the already solid rock. Since the whole complex is generally rich in rare minerals and elements, it might be interesting to do a chemical analysis of these pegmatites.

There are also some features of geochemical interest, one being the agpaiitic sequence of crystallization in the altered intersertal syenite. Another is the interaction among various rock types evident in the xenoliths and surrounding rocks, and the contact between various veins. To mention a few, the xenoliths of gabbro in syenite (stop 7), remained fresh and retained sharp boundaries; the rhombopyres and breccia at the same stop showed similar features. But several hundred feet away, the two series of syenite veins in the so-called nephelene syenite veins showed where they cross-cut each other in a complete fusion of their contact. This can be explained by the similarities and differences in the composition of the host and foreign material. When syenite veins meet and cut each other, it is not hard chemically for solution and recrystallization near the contact, whereas the reaction between a gabbro and a syenite is much more difficult, if not impossible. The alteration in nephelene syenite to colourful zeolite might be worth studying too.

Mineralization occurred in several places. Common ores such as pyrrhotite, pyrite, chalcopyrite and iron oxides were seen in many outcrops in small amounts. But at stop 1 the molybdenite associated with laurvakite is rather rare. Further study might reveal yet other interesting elements and minerals such as titanium. At stop 8 large amounts of magnetite were seen either in nearly pure forms or injected into the surrounding rocks such as syenite and gabbro.

Besides the rhombopyre dykes mentioned above, there are several dykes cutting the complex. At stop 3 two vertical dykes cut the syenite. These and the one at stop 7 were diabasic and might be related to the Keeweenawan extrusives in Central Canada. Also at stop 8 there were several series of high angle dykes of olivine-basalt in various host rocks. These and other structures, such as the sill of basalt at stop 6 might be the equivalent of Animekie extrusives, but further study is necessary to substantiate this. One way to do this is by radiometric dating and the initial 87Sn/86Sn ratio which should be the same for all co-magmatic rocks. These and other studies might reveal the relationship of these structures to the other regional phenomena, such as the dykes which might be feeders to the regional Keeweenawan extrusives.

The rocks in the complex itself are very interesting and spectacular in their variety, texture, rare minerals and elements, and in the sequence of crystallization. Economically the potential of nephelene syenite and laurvakite for construction material, and the other rare elements might be worth investigating. Further study may contribute to the understanding of pre-Cambrian stratigraphy in the Canadian Shield or even in the crust.

Fused contact in nephelenized syenite vein cutting each other.

Drill hole mistaken for a quartz vein in laurvakite by third year.

Subsequent Field Trips

1. Sibley Penninsula field trip
2. Kakabeka Falls - Armstrong field trip
3. Shebandowan field trip
4. Shebandowan underground field trip